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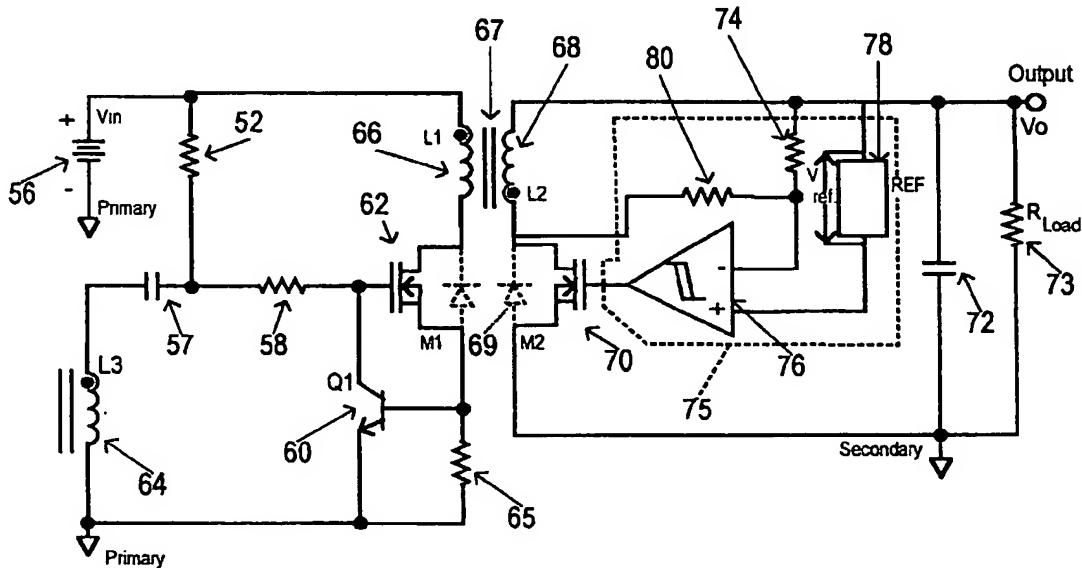
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(75) Inventor/Applicant (*for US only*): JITARU, Ionel, D.

(54) Title: SOFT SWITCHING HIGH EFFICIENCY FLYBACK CONVERTER



(57) Abstract: DC-DC converters such as flyback converters achieve self-regulation by communication information between primary and secondary circuits through the power transformer. Operating in accordance with a generalized concept or algorithm, the converter can be bi-directional and self-regulating. Control of the turn OFF times of semiconductor switches in first and second circuits coupled to first and second windings of the power transformer determines whether power flow is in one direction through the converter or the other direction. Turn ON timing of each semiconductor switch is when there is a reverse current through the switch and voltage across the switch is at or near zero. Turn OFF of a switch can be controlled from one or more operating parameters of the converter such as output voltage, in which case the converter's self-regulation is affected through duty cycle variation with variations in output voltage.

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INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02M3/335

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 084 784 A (THOMAS DÜRBAUM) 4 July 2000 (2000-07-04)	1,2,5-8, 10,21, 23,26, 27, 30-33,41
Y	the whole document -----	4,9,28, 29,35
X	US 5 745 351 A (CHRISTOPHE TAURAND) 28 April 1998 (1998-04-28)	1,2,5-8, 10,21, 23,26, 27, 30-33,41
	abstract figures 10,11 column 12, line 1 - line 24 ----- -/-	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 768 118 A (RICHARD A.FAULK) 16 June 1998 (1998-06-16)	1,2,5-8, 10,21, 23,26, 27, 30-33,41
	abstract figures 1,2 column 5, line 22 - column 9, line 5 -----	
X	US 5 594 629 A (ROBERT L.STEIGERWALD) 14 January 1997 (1997-01-14)	1,3,11, 12,34, 36-40,42
Y	the whole document -----	4,9,28, 29,35
X	US 5 109 326 A (HUBERT C. MARTIN) 28 April 1992 (1992-04-28)	1,3,11, 12,34, 36-40,42
	figures 1,2 column 2, line 32 - line 40 column 7, line 20 - line 58 -----	
X	EP 0 336 725 A (MATSUSHITA ELECTRIC INDUSTRIAL CO.) 11 October 1989 (1989-10-11)	1,3,11, 12,34, 36-40,42
	abstract page 3, line 55 - line 58 page 10, line 29 - line 31 page 10, line 40 - line 43 page 10, line 51 - line 52 -----	
X	PATENT ABSTRACTS OF JAPAN vol. 1995, no. 06, 31 July 1995 (1995-07-31) & JP 07 067329 A (MATSUSHITA ELECTRIC IND.), 10 March 1995 (1995-03-10)	1,3
	abstract -----	
X	US 5 321 597 A (JEAN-CLAUDE ALACOQUE) 14 June 1994 (1994-06-14)	1
	column 3, line 63 - line 65 column 4, line 66 - line 3 column 10, line 41 - line 53 -----	
A	US 6 198 638 B1 (SANG YUN LEE) 6 March 2001 (2001-03-06)	1,3,11, 12,34, 36-40,42
	column 1, line 8 - line 15 column 2, line 58 - line 65 column 7, line 26 - line 39 -----	
	-/-	

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CH 03/00244

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AT 399 432 B (SIEMENS AKTIENGESELLSCHAFT) 26 May 1995 (1995-05-26) abstract page 4, line 30 - line 35 figure 1 -----	1
A	US 6 069 804 A (THOMAS M. INGMAN ET AL.) 30 May 2000 (2000-05-30) abstract figures 1,3 -----	10
A	US 5 719 755 A (HIROSHI USUI) 17 February 1998 (1998-02-17) figures 1,4-6 column 7, line 2 - line 10 column 7, line 25 - line 33 -----	41
P,X	WO 03 003552 A (KONINKLIJKE PHILIPS) 9 January 2003 (2003-01-09) the whole document -----	1-8, 10-12, 21,23, 26-42

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CH 03/00244

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-8,10-12,21,23,26-42

Remark on Protest

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: -

Claim 1: Last part of the claim specifies: "...and enabling the turning ON of that semiconductor switch when a reverse current through the semiconductor switch is detected." The semiconductor is clearly OFF (in order to be able to turn it ON) when the reverse current in the switch is detected. When a switch is OFF it is not capable of conducting current and "...a reverse current through the semiconductor switch..." cannot be detected. This part of the claim does not make sense the way it is phrased.

Turning to the description a possible alternative "interpretation" becomes possible: (page 8, lines 2-3) "...the secondary current 88 starts to flow through the body diode 69 of a MOSFET M2."; a current that can be called "reverse" is starting to flow through a diode in parallel with the switch, for a MOSFET switch this diode may be the body diode (intrinsic).

Hence, the "interpretation" used for the search is that the Switch is switched ON when a "reverse" current in a diode parallel to the switching element is detected.

The specification "a self-regulating DC-DC converter" is not an unambiguous term that is well established in the field. Hence, "self-regulating" is not considered as a valid specification of a group of technical features and the word "self-regulating" is disregarded when evaluating the claims.

In the description (page 4-5) the applicant indicates that he considers "a self-regulating DC-DC converter" to be a DC-DC converter with a secondary regulation scheme as described in some of the embodiments. If the applicant considers any of the technical features relating to this secondary regulation scheme for important special technical features, these features must be included in the claims.

Claim 43: The contents of claim 43 is not clearly supported by a particular part of the detailed description, does not contain any references to the figures and the effect caused by the features claimed are not evident without support. As figure 1a is the only figure that discloses a voltage reference element and figure 1a seem to disclose other features being claimed in claim 43, it is assumed that claim 43 relates to the characteristics of figure 1a.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8 10-12 21 23 26-42

A DC-DC converter,

with a semiconductor switch being turned on at a time subsequent to detection of a reverse current through that switch, while current in that switch is still reverse current and when voltage across that switch has reached substantially zero volts.

2. claim: 9 22 24 25

A DC-DC converter,

with a control winding wound on the power transformer.

3. claims: 13-20

A self-regulating DC-DC converter,

with a control circuit that senses an over-voltage condition and transfers energy back to the primary winding circuit from the secondary winding circuit at a level depending on the level of over-voltage.

4. claim: 43

A method of DC-DC conversion,

including sensing a voltage related to an output voltage with a secondary circuit, comparing that voltage with a reference voltage and turning on a secondary switch when the voltage bears a predetermined relationship to the reference voltage.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CH 03/00244

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 6084784	A	04-07-2000	DE EP JP KR TW	19828038 A1 0967714 A2 2000037074 A 2000006319 A 437146 B		30-12-1999 29-12-1999 02-02-2000 25-01-2000 28-05-2001
US 5745351	A	28-04-1998	FR EP JP	2729516 A1 0722211 A1 8275513 A		19-07-1996 17-07-1996 18-10-1996
US 5768118	A	16-06-1998	US	5757627 A 5745358 A 5764495 A 5841641 A 5745359 A		26-05-1998 28-04-1998 09-06-1998 24-11-1998 28-04-1998
US 5594629	A	14-01-1997		NONE		
US 5109326	A	28-04-1992		NONE		
EP 0336725	A	11-10-1989	DE DE EP JP JP US	68916995 D1 68916995 T2 0336725 A2 2261053 A 2773195 B2 4958268 A		01-09-1994 09-02-1995 11-10-1989 23-10-1990 09-07-1998 18-09-1990
JP 07067329	A	10-03-1995		NONE		
US 5321597	A	14-06-1994	FR AT CA DE DE DK EP ES GR JP JP MX	2674385 A1 140831 T 2063637 A1 69212355 D1 69212355 T2 505283 T3 0505283 A2 2090539 T3 3021101 T3 3170337 B2 5160761 A 9201257 A1		25-09-1992 15-08-1996 23-09-1992 29-08-1996 28-11-1996 04-11-1996 23-09-1992 16-10-1996 31-12-1996 28-05-2001 25-06-1993 01-10-1992
US 6198638	B1	06-03-2001	JP KR	2000224849 A 2000071270 A		11-08-2000 25-11-2000
AT 399432	B	26-05-1995	AT	175791 A		15-09-1994
US 6069804	A	30-05-2000	WO	0007287 A2		10-02-2000
US 5719755	A	17-02-1998	JP JP	2845188 B2 9163736 A		13-01-1999 20-06-1997
WO 03003552	A	09-01-2003	WO	03003552 A2		09-01-2003